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Evaluation of Physicochemical Quality of Shea Butter Sold from Ouagadougou, Burkina Faso

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ABSTRACT

Shea butter is a traditional product known for its many virtues. Thus, the main objective of this study was to evaluate the biochemical quality of shea butter sold in Ouagadougou, Burkina Faso. The different biochemical parameters of the samples were determined and compared according to ISO standards. For moisture content and insoluble impurities, for the 18 samples studied it was found that 1.14% against 0.20% maximum limit set by the Codex Alimentarius, 7.40% on average against 0.20% m / m respectively. For chemical parameters, the acid value was equal to 8.42 mg KOH/g against 3 mg KOH / g as the maximum limit of the standard set by the Codex Alimentarius. Peroxide index was equal to 20.79 mg O_2/kg against 15 mg O_2/ kg as the maximum limit of the standard. The average saponification number was 206.95 mg KOH / g against 195 mg KOH / g as the maximum limit set by the Codex Alimentarius. Results from the study show none of the samples satisfied the standard limits set by the codex Alimentarius. To this effect, certification organizations should make production manuals available to producers.

Keywords: Butter, Chemical Parameters, Shea

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INTRODUCTION

Shea Butter is an edible vegetable substance extracted from shea fruits (*Vitellaria paradoxa* or *Butyrospermum parkii*), a tree growing in the wooded savannahs of Burkina Faso and West Africa (Bonkoungou, 1987). From its almonds is extracted its butter used in cooking and as a substitute for cocoa butter in the manufacture of chocolate (Nafan, 2000). Shea butter is very appraised in the food, cosmetics and pharmaceutical's industries (Soro et al., 2011; Gnangle et al., 2012; Kouyate et al., 2015), for its intrinsic properties that is related to its glyceride composition and its high content of unsaponifiables (Kapseu et al., 2001). In several West African countries, the production of this butter occupies an important place in economic activities. In Burkina Faso, the production of shea butter is also an important sector of the economy and is generally led by women (individually as well as collectively) making them capable to finance most of their activities, thus implying a greater power of women with regard to women, gender and development (Zacharie et al., 2011). The production of shea butter is traditional and does not yet know any standard and manufacturing processes differ from one producer to another (Kassamba, 1997) . This leads to a variety of kinds of butter found in the market (Hall et al., 1996; Schreckenberg, 1996; Kapseu et al., 2005; Womeni et al., 2006). These butter are intended for both export and local consumption, and some studies have been directed towards increasing the production of fruits and shea butter (Coulibaly et al., 2004; Odebiyi et al., 2004; Lamien et al., 2006), while others have been directed at improving the quality of the butter (Bayala et al., 2003; Lamien et al., 2006). It is therefore

Table 1. Study's samples.

Samples collected from Markets	Samples from Supermarkets
EZD1 and EZD2 collected from Zabr-daaga ELY1 and ELY2 collected from Larle-yaar EOY1 and EOY2 collected from Oscar-yaar ECA1 and ECA2 collected from City and II market BK_ENY1 and ENY2 collected from Nabi-yaar EKY1 and EKY2 collected from Katr-yaar EMPO1 and EMPO2 collected from Patte d'Oie market ESY collected from Sankar-yaar EK: „Karicos„ sample collected from a shop in Zabr-daaga;	EPK: Kariqueen sample collected from the supermarket "Le Privilege"; ECP: sample „claire production„ collected from the supermarket "Le bon exemple"

important to know if this butter has quality in accordance with the international standards of nutrition and diet. This study aims to evaluate the quality of shea butter sold in the markets of Ouagadougou, Burkinafaso.

MATERIALS AND METHODS

Sampling

Eighteen samples were collected from different markets and supermarkets in the city of Ouagadougou. The samples and the site they were collected from are summarized in Table1.

Determination of Moisture Content and Volatile Matter

Principle (ISO 662)

Heating the product to 103 ± 2°C until complete elimination of water and volatile matter and determination of mass loss.

Operating Mode

To determine the humidity of shea butter, beakers were oven-dried. 10 g of shea butter was weighed into these beakers (test weight). The beakers containing the butter was placed in the oven for 1 h at 105°C and thereafter weighed (P1) and returned to the oven for 30 min at 105°C and re-weighed.
The water content and volatile matter are expressed as a percentage using the following formula:

$$Te.mv\ (\%) = \frac{M1-M2}{PE} x100 \text{ or } Te.mv\ (\%) = \frac{M1-M2}{M1-M0} x100$$

M0: Mass in g of the crystallizer
M1: Mass in g of the crystallizer and the test sample (PE)
M2: Mass in g of the crystallizer and the test sample after drying.
PE: Trial taking.

Determination of Insoluble Impurities Content

Principle (ISO 663)

The insoluble impurities content corresponds to the mass of impurities expressed in g per 100 g of fat. It involves the treatment of a sample with an excess of n-hexane or petroleum ether and filtration of the solution obtained. The filter and the residue is washed with the same solvent and dried at 103°C and weighed.

Operating Mode

To determine the value of the impurities in the shea butter, 20 g of the butter are weighed into an Erlenmeyer flask. 150 to 200 ml of hexane is then added to the butter contained in the Erlenmeyer flask and allowed to stand for 30 min to completely dissolve the oil in the solvent (hexane). The oil is subsequently filtered into another Erlenmeyer flask. The Erlenmeyer flask is rinsed with hexane to filter. The filter paper used was first weighed before starting the filtering after removing it from the oven. The filter paper was recovered after filtering and placed back in the oven. It finally removed it and weigh again deduction made.
The content of insoluble impurities is expressed as a percentage according to the formula

$$Timp = \frac{Mimp}{PE} x100$$

Timp: impurity rate
Mimp: mass of impurities
PE: test portion

Determination of the Acid-Number

Principle (ISO 660)

This is done by neutralizing the free acids using potassium hydroxide (KOH) or caustic potash.

Operating Mode

To determine the acid number, 10 g of shea butter was weighed into an Erlenmeyer flask. In another empty Erlenmeyer flask, 50 ml of di-ethyl ether was measured and 15 drops of phenolphthalein and a few drops of potassium hydroxide (0.1N KOH) were added. A pink

solution is formed after the addition of KOH. When a 10g of shea butter was added, the pink solution turns white. The white solution formed is then titrated with KOH (0.1N) until the pink color reappears. The volume of KOH used up is measured.
The acid number is expressed in milligram of KOH per gram of oil using the following formula:

$$Ia = \frac{VxTx56,1}{P} \text{ (mg of KOH/g)}$$

V: volume of the KOH solution;
T: title of the KOH solution;
P: test sample;
56.1: molar mass of KOH.

Determination of the Peroxide Index

Principle (ISO 660)

Treatment of a test portion, in solution of acetic acid and chloroform with a solution of potassium iodide. Titration of iodine released by a standard solution of sodium thiosulfate.

Operating Mode

Weigh 2 g of shea butter in an Erlenmeyer flask. Add 10 ml of chloroform, 15 ml of acetic acid, 1 ml of potassium iodide using a micropipette. Shake for about a minute and leave in the dark for 5 min. Then add about 75 ml of distilled water, then a few drops of starch. Titrate with thiosulfate (0.01N thiosulfate) and read the volume of thiosulfate consumed.
The peroxide number is expressed in milliequivalents of active oxygen per kilogram of oil according to the formula below:

$$Ip = \frac{(V1 - V0)T}{M} X1000 \left(\frac{mEqO2}{kg} of\ oil\right)$$

V1: Volume of the standard solution of sodium thiosulfate used for the determination in ml
V0: Volume of the standard solution of sodium thiosulfate used for the blank, in ml
T: The normality of the sodium thiosulfate solution used.
M: The mass in grams of the test sample.

Determination of the Saponification Index

Principle (ISO 3657)

The saponification number of a fatty substance is the weight of KOH expressed in milligrams to neutralize the fatty acids resulting from the hydrolysis of 1 g of this fatty substance.

Operating Mode

Weigh 2 g of oil into an Erlenmeyer flask, then add 25 ml of sodium hydroxide (0.5N KOH). Add a few grains of a boiling regulator and allow it to boil for one hour. After boiling for an hour, remove the flask from the heat and add 1 ml of phenolphthalein. Titrate with 0.5N HCL and record the consumed titrant.
The saponification index is expressed as follows:

$$Is = \frac{Vol(white) - Vol(sam)xC(HCL)x56.1}{PE}$$

Vol (white): volume of the titrant solution consumed by the white.
Vol (sam): volume of the titrant solution consumed by the sample.
C (HCl): concentration of HCl titrant (0.5N).
PE: test weight.
56.1: molar mass of KOH.

RESULTS AND DISCUSSION

Physical Analysis

The physical analysis consisted of the evaluation of the content of volatile matter or water and insoluble impurities. The results of the physical analysis of samples analyzed are shown in Table 2. The moisture content of all 18 samples ranged from 0.06 to 2.80% with an average of 1.14%. The lowest moisture content was observed on the ECP sample and the largest on the ENY1 sample. The majority of the samples (07) had a content of between 1.10 and 1.90%. According to the codex Alimentarius classification which categorizes unrefined shea butter into two groups: category 1^a including Te. Vol must be max ≤ 0.05 and category 1^b with an interval between 0.06 and 0.20%. None of the analyzed samples were in category 1^a since ECP is a refined butter. Ignoring EPK and EK which are refined butter, only EOY2 was housed in category 1^b with 0.10%. All other samples did not fall under the codex Alimentarius classification. According to Kiyayila (2002), traditional manufacturing processes, including the use of water for butter extraction, could be responsible for these high levels of water content. Hall et al. (1996), argue that the high water content could be explained by post-preparation adulteration with water.
Butter in category 2 of the Codex Alimentarius classification could meet the needs of the food industry (confectionery, chocolate, edible oil or even as a base for margarine).
The insoluble impurities content in the samples ranged from 4.80 to 13.39%, including 4.80% for ECP and 13.39% for EZD1 with an average of 7.40%. The codex Alimentarius classifies butter at this level into two categories as well. The first category, the content of which must be ≤ 0.09%, and the second category, the content of which must be between 0.1 and 0.20%. When compared with this categorization, the samples analyzed

Table 2. Results of volatile matter or in water and insoluble impurities.

	Te. Vol (%)	Impurity Content (%)
ESY	1.950[c]	7.530[g]
EMPO1	1.520[d]	7.100[h]
ENY1	2.800[a]	5.790[l]
ELY1	0.700[g]	10.525[b]
ENY2	1.500[d]	5.460[n]
EKY1	1.530[d]	9.450[d]
EOY2	0.100[k]	6.460[i]
ECA1	1.200[e]	9.690[c]
EKY2	1.2 [e]	6.450[i]
EMPO2	1.500[d]	8.490[e]
ECA2	2.600[b]	6.120[j]
EPK	0.250[i]	5.900[k]
EOY1	1.515[d]	7.690[f]
ELY2	1.100[f]	5.300[o]
EZD1	0.300[i]	13.390[a]
ECP	0.060[kl]	4.800[p]
Normes 1	0.050[kl]	0.090[q]
EK	0.170[j]	0.000[q]
EZD2	0.600[h]	5.690[m]
Normes 2	0.020[l]	0.020[q]

Table 3. Acid index results; of peroxide index and saponification index of shea butters.

Samples	Acid Index	Peroxide Index	Saponication Index
ESY	1.950[c]	7.530[g]	8.100[i]
EMPO1	1.520[d]	7.100[h]	13.740[b]
ENY1	2.800[a]	5.790[l]	9.840[e]
ELY1	0.700[g]	10.525[b]	8.330[h]
ENY2	1.500[d]	5.460[n]	20.550[a]
EKY1	1.530[d]	9.450[d]	6.390[m]
EOY2	0.100[k]	6.460[i]	11.890[d]
ECA1	1.200[e]	9.690[c]	8.550[g]
EKY2	1.200[e]	6.450[i]	13.290[c]
EMPO2	1.500[d]	8.490[e]	7.710[k]
ECA2	2.600[b]	6.120[j]	5.200[o]
EPK	0.250[i]	5.900[k]	9.140[f]
EOY1	1.515[d]	7.690[f]	6.545[l]
ELY2	1.100[f]	5.300[o]	2.520[q]
EZD1	0.300[i]	13.390[a]	5.620[n]
ECP	0.060[kl]	4.800[p]	4.770[p]
Normes 1	0.050[kl]	0.090[q]	8.000[ij]
EK	0.170[j]	0.000[q]	1.290[r]
EZD2	0.600[h]	5.690[m]	7.995[j]
Normes 2	0.020[l]	0.020[q]	1.000[s]

were neither in the first nor in the second range. Insoluble impurities are inherent in shea kernels (Sanou, 2002; Ouedraogo, 2002; Kitamura et al., 2003; Mbah et al., 2005) or the crude means and methods used in the production of the butter.
No value for EK was recorded since is not dissolved in hexane. This made filtration difficult. Since it can be used in cosmetics, it could be mixed with other compounds.

Chemical Analysis

The chemical analysis consisted of the measurement of the acid number, peroxide and saponification index. The results of the chemical analysis of analyzed samples are presented in Table 3. The acid value analysis gave well-spaced values ranging from 1.29 (EK) to 20.55 (ENY2) with an average of 8.42 mg KOH / g oil. These values of the acid number indicated that the butter was a little rancid. This could be explained by a conversion of triglycerides to free fatty acids and glycerol (Kapseu et al., 2001). Chantal (2007), citing UEMOA standards, a premium quality shea butter should have a max acid value equal to 1.0 mg KOH / kg; that of second quality between 1.1 and 3.0 and that of a third quality between 3.1 and 8.0. The analysis of 18 samples yielded peroxide index values in the range of 1.99 mEq O_2 / kg of oil to

235. However, most of the samples had indices less than ten (10). The average was 20.80 mEq O_2 / kg. According to the Codex Alimentarius standard which states that the best quality of shea butter must have a peroxide value ≤ 10.15, the samples had a good peroxide value. The second category of shea butter according to this same standard should have a peroxide value ≤ 15.

One of the samples fits in this second category with 10.47 mEq O_2 / kg. The other two (EPK and ELY1) had non-standard indices. Most of the butter was not oxidized enough and was in a good range. However, EPK and ELYN1 seemed to be much oxidized. This may be due to the presence of metals (iron and copper) which can be linked to the materials used for production or it can be linked to external factors (light and heat). However, the peroxide index is only an indicator of the onset of oxidation, which increases to reach a peak and then decreases with the oxidation state. The peroxides then form volatile (organizations) and non-volatile aldehyde compounds (long-chain carbon aldehydes). This index can be linked to another index that is the anisidine index to give the TotOx parameter (Total Oxidation). The anisidine index, allows for better evaluatation of the oxidation of fat taking into account the different forms of oxidation of fatty acids. The results obtained for the saponification number ranged from 100.028 (EZD1) to 254.81 mg KOH / g (ENY2) with an average of 206.95 mg KOH / g in general. According to the Codex Alimentarius standard, the range is from 160 to 195. Based on the study results, only six samples were in this range; two were below and the other ten was above this norm. The result from previous studies shows that the higher the molar mass, the lower the saponification number. Womeni et al. (2006), this could be an explanation for shea butter extraction methods.

CONCLUSION

The study of physicochemical parameters of shea butter showed that shea butter sold in the Ouagadougou market was not of good quality. At first glance, none of the samples met all the limits set by the Codex Alimentarius standard. Many shea butter sold in the Ouagadougou market oxidizes easily due to the high peroxide index value recorded in the study. The shea butter also contained many insoluble impurities and cannot be consumed directly without prior treatment. This butter also contained enough water which facilitates their degradation over time.

However, many of these butter would be much more beneficial in soap making due to their high saponification indices when compared to the food standard of Codex Alimentarius.

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